

CLAIMS

What is claimed is:

1           1. A switching regulator, comprising:  
2           a power switch coupled between first and second terminals, the first  
3           terminal to be coupled to an energy transfer element of a power supply and the  
4           second terminal to be coupled to a supply rail of the power supply;  
5           a control circuit coupled to a third terminal and the power switch, the third  
6           terminal to be coupled to an output of the power supply, the control circuit  
7           coupled to generate a feedback signal responsive to the output of the power  
8           supply, the control circuit coupled to switch the power switch in response to the  
9           feedback signal, the control circuit coupled to switch the power switch at a fixed  
10          switching frequency for a first range of feedback signal values, the control circuit  
11          coupled to vary a switching frequency of the power switch without skipping  
12          cycles in response to the feedback signal for a second range of feedback signal  
13          values.

1           2. The switching regulator of claim 1 wherein the control circuit  
2           comprises:  
3           a feedback signal circuit coupled to the third terminal, the feedback signal  
4           circuit coupled to generate the feedback signal; and  
5           a pulse width modulator circuit coupled to switch the power switch in  
6           response to the feedback signal.

1           3. The switching regulator of claim 1 wherein the first and second ranges  
2 of the feedback signal correspond to first and second ranges of levels of a load  
3 coupled to the output of the power supply.

1           4. The switching regulator of claim 2 wherein the first and second ranges  
2 of the feedback signal correspond to first and second ranges of on-time values of a  
3 drive signal generated by the pulse width modulator circuit to switch the power  
4 switch.

1           5. The switching regulator of claim 2 wherein the first and second ranges  
2 of the feedback signal correspond to first and second ranges of duty cycle  
3 percentage values of a drive signal generated by the pulse width modulator circuit  
4 to switch the power switch.

1           6. The switching regulator of claim 2 wherein an off-time value of a drive  
2 signal generated by the pulse width modulator circuit to switch the power switch  
3 varies as a function of a level of a load coupled to the output of the power supply  
4 to vary the switching frequency of the power switch without skipping cycles for  
5 the second range of feedback signal values.

1           7. The switching regulator of claim 2 wherein on-time and off-time values  
2 of a drive signal generated by the pulse width modulator circuit to switch the

3 power switch vary simultaneously as a function of a level of a load coupled to the  
4 output of the power supply to vary the switching frequency of the power switch  
5 without skipping cycles for the second range of feedback signal values.

1 8. The switching regulator of claim 7 wherein the off-time value of the  
2 drive signal is varied as a function of the on-time value and a first on-time value  
3 of the drive signal, the first on-time value of the drive signal corresponding to an  
4 on-time of the drive signal at a boundary between the first and second ranges of  
5 feedback signal values.

1 9. The switching regulator of claim 2 wherein the switching frequency of  
2 the power switch is reduced without skipping cycles for the second range of  
3 feedback signal values as a level of load coupled to the output of the power supply  
4 is reduced.

1 10. The switching regulator of claim 9 wherein the switching frequency of  
2 the power switch is reduced without skipping cycles to a minimum frequency  
3 when a duty cycle percentage value of a drive signal generated by the pulse width  
4 modulator circuit to switch the power switch is substantially equal to zero percent.

1 11. A power supply, comprising:  
2 an energy transfer element having an energy transfer element input and an  
3 energy transfer element output coupled to an output of the power supply;

4 a switching regulator circuit including a power switch coupled to the  
5 energy transfer element input, and a control circuit coupled to the power switch  
6 and the output of the power supply, the control circuit coupled to generate a  
7 feedback signal responsive to the output of the power supply, the control circuit  
8 coupled to switch the power switch in response to the feedback signal, the control  
9 circuit coupled to switch the power switch at a fixed switching frequency for a  
10 first range of feedback signal values, the control circuit coupled to vary a  
11 switching frequency of the power switch without skipping cycles in response to  
12 the feedback signal for a second range of feedback signal values.

1 12. The power supply of claim 11 wherein the control circuit comprises:

2 a feedback signal circuit coupled to the output of the power supply, the  
3 feedback signal circuit coupled to generate the feedback signal; and

4 a pulse width modulator circuit coupled to switch the power switch in  
5 response to the feedback signal.

1 13. The power supply of claim 12 further comprising an output sense  
2 circuit coupled between the output of the power supply and the switching  
3 regulator circuit, the output sense circuit coupled to provide an output sense signal  
4 to the switching regulator that is proportional to an output voltage or current  
5 supplied by the output of the power supply, wherein a duty cycle variation  
6 provided by a drive signal generated by the pulse width modulator circuit to  
7 switch the power switch is inversely proportional to the output sense signal.

1           14. The power supply of claim 11 wherein the first and second ranges of  
2 the feedback signal correspond to first and second ranges of levels of a load  
3 coupled to the output of the power supply.

1           15. The power supply of claim 12 wherein the first and second ranges of  
2 the feedback signal correspond to first and second ranges of on-time values of a  
3 drive signal generated by the pulse width modulator circuit to switch the power  
4 switch.

1           16. The power supply of claim 12 wherein the first and second ranges of  
2 the feedback signal correspond to first and second ranges of duty cycle percentage  
3 values of a drive signal generated by the pulse width modulator circuit to switch  
4 the power switch.

1           17. A method for regulating a power supply, comprising:  
2           switching with a drive signal a power switch coupled to an energy transfer  
3 element of the power supply to control power delivered to an output of the power  
4 supply;  
5           generating a feedback signal in response to the output of the power supply;  
6           maintaining a frequency of the drive signal at a fixed frequency for a first  
7 range feedback signal values; and

8 varying the frequency of the drive signal without skipping cycles in  
9 response to the feedback signal for a second range of feedback signal values.

1 18. The method for regulating the power supply of claim 17 further  
2 comprising varying a duty cycle of the drive signal substantially in response to the  
3 feedback signal.

1 19. The method for regulating the power supply of claim 17 wherein  
2 generating the feedback signal in response to the output of the power supply  
3 comprises monitoring a current representative of a level of the load coupled to the  
4 output of the power supply.

1 20. The method for regulating the power supply of claim 18 wherein  
2 generating the feedback signal in response to the output of the power supply  
3 comprises monitoring an on-time of the drive signal.

1 21. The method for regulating the power supply of claim 20 wherein  
2 monitoring the on-time of the drive signal comprises timing the on-time of the  
3 drive signal with a timer circuit, the method further comprising suspending  
4 operation temporarily of an oscillator circuit if the on-time of the drive signal is  
5 less than a first on-time value.

1           22. The method for regulating the power supply of claim 21 wherein  
2 timing the on-time of the drive signal with the timer circuit comprises  
3           discharging a capacitor at a first rate during the on-time of the drive signal;  
4 and  
5           discharging the capacitor at a second rate during an off-time of the drive  
6 signal, the first rate greater than the second rate.

1           23. The method for regulating the power supply of claim 22 further  
2 comprising maintaining a voltage level of a suspended oscillating signal generated  
3 by the oscillator circuit while the operation of the oscillator circuit is temporarily  
4 suspended.

1           24. The method for regulating the power supply of claim 23 further  
2 comprising resuming operation of the oscillator circuit after the capacitor has been  
3 discharged.

1           25. A switching regulator, comprising:  
2           a power switch coupled between first and second terminals;  
3           a control circuit coupled to a third terminal and coupled to the power  
4 switch, the control circuit coupled to receive an output sense signal responsive to  
5 an output of a power supply, the control circuit coupled to generate a drive signal  
6 to switch the power switch in response to the output sense signal to control the  
7 output of the power supply; and

8 a timer circuit included in the control circuit, the timer circuit coupled to  
9 time an on-time of the drive signal, the timer coupled to the control circuit to vary  
10 a switching frequency of the drive signal without skipping cycles if the on-time of  
11 the drive signal is less than a first on-time value, the drive signal to have a fixed  
12 switching frequency if the on-time of the drive signal is greater than the first on-  
13 time value.

1 26. The switching regulator of claim 25 wherein the timer circuit  
2 comprises a capacitor that is coupled to be charged and discharged in response to  
3 the drive signal, the capacitor to be discharged at a first rate during the on-time of  
4 the drive signal, the capacitor coupled to be discharged at a second rate during an  
5 off-time of the drive signal, the first rate greater than the second rate.

1 27. The switching regulator of claim 26 wherein the timer circuit further  
2 comprises first and second current sources coupled to discharge the capacitor at  
3 the first rate, the second current source coupled to discharge the capacitor at the  
4 second rate.

1 28. The switching regulator of claim 26 wherein the control circuit  
2 comprises an oscillator circuit coupled to generate an oscillating signal, the  
3 oscillator circuit to suspend generating the oscillating signal if the on-time of the  
4 drive signal ends prior to the capacitor being discharged, the oscillator circuit



1           29. The switching regulator of claim 28 wherein the oscillator circuit is  
2   coupled to maintain a voltage level of the oscillating signal while the oscillator  
3   circuit is suspended, the oscillator circuit is coupled to resume the oscillating  
4   signal from the maintained voltage level.